# UNIVERSITA' DEGLI STUDI DI MILANO
# PROGRAMME DESCRIPTION - ACADEMIC YEAR 2025/26
# BACHELOR
# PHYSICS (Classe L-30 R)
# Enrolled in 2025/2026 Academic Year

## *HEADING*

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| **Degree classification - Denomination and code:** | L-30 R |
| **Degree title:** | Dottore |
| **Length of course:** | 3 years |
| **Total number of credits required to complete programme:** | 180 |
| **Years of course currently available:** | 1st |
| **Access procedures:** | Open, subject to completion of self-assessment test prior to enrolment |
| **Course code:** | FAN |

## *PERSONS/ROLES*

**Head of Study Programme**

Prof.ssa Alessandra Guglielmetti

**Tutors - Faculty**

Tutor per l'orientamento
F. Camera, S. Cialdi, G. Colò, S. D'Auria, L. Gariboldi, A. Guglielmetti, G. Lodato, N. Manini, L.G. Molinari, S. Olivares, M. Paris, P. Piseri, M. Sorbi, D. Tamascelli, A. Vicini

Tutor per i piani di studio (Study plan tutor)
A. Guglielmetti

Tutor per la mobilità internazionale e l'Erasmus (Erasmus and International mobility)
N. Piovella

Tutor per stage e tirocini (Internship tutor)
N. Piovella, A. Guglielmetti

Tutor per laboratori e altre attività (Laboratory Classes)
R. Vecchi

**Tutors - Students**

BEDODI NICOLA
BORINGHIERI GIACOMO
DE NARDI GIACOMO ANGELO MARIA
EZZAHRANY KHADIJA
FERRARIO MARTINO
FURLAN ANITA
GALLAVOTTI FILIPPO
GHEORGHIU GIUSEPPE
GIULIANI BEATRICE
INSALACO LUDOVICO MARIA
IOSA BEATRICE
LAZZARA VIRGINIA
MAURI FILIPPO
PEDROTTI LORENZO
PICONE FEDERICO
SERGI NICCOLO'

**Degree Course website**

https://fisica.cdl.unimi.it/it

**Dissertation and Final Exam**

L. Bonizzoni (Presidente), C. Benedetti, F. Camera, S. Carrazza, V. Liberali, D. Maino

**Laboratory Security**

M. Potenza

**Library**

Via Celoria 18 - 20133 Milano http://www.sba.unimi.it/Biblioteche/bicf/13453.html

**Matriculation**

https://www.unimi.it/it/node/183

**Outreach**

https://unimibox.unimi.it/index.php/s/d3z27gH8KLosixk

**PLS Program Chair**

M. Giliberti

**Program Transfer**

G. Maero, C. Barbieri, M. Genoni, S. Riboldi Email: commissione.ammissione@fisica.unimi.it

**Schedule of Classes**

S. Bottoni, M. Gherardi

**Specific Learning Disabilities**

L. Carminati

**Student Registrar**

Phone 0250325032 https://www.unimi.it/it/studiare/servizi-gli-studenti/segreterie-informastudenti

**Study Program Office**

Via Celoria, 16 - 20133 Milano Phone 02.50317401 https://informastudenti.unimi.it/saw/ess?AUTH=SAML

**TOLC test coordinator**

L. Gariboldi

## *CHARACTERISTICS OF DEGREE PROGRAMME*

**General and specific learning objectives**

General and Specific Educational Objectives

The primary objective of the Bachelor's Degree in Physics is to provide graduates with a solid foundation in basic physics, encompassing both classical and modern physics. The theoretical courses enable students to acquire an understanding of the fundamental concepts of physics, while laboratory courses provide knowledge of techniques and methodologies for data analysis in experimental settings.

Graduates will be able to apply the fundamental methods of scientific research to the modeling of complex systems, even in fields beyond physics. The program also provides knowledge of mathematical and computational tools that are essential for describing physical phenomena and their numerical modeling. All the basic physics knowledge and methodological tools gained by graduates will serve as a foundation for specialization in various branches of physics through a master's degree program and potentially a subsequent doctoral program. Additionally, these skills are valuable for those who choose to enter the job market directly.

The program features mandatory theoretical and experimental education across a broad spectrum, with a duration of three years, divided into semesters. In the first year, students acquire foundational knowledge in differential and integral calculus, algebra, geometry, computer science, and fundamental concepts of classical physics.

In the second year, students delve into core topics in classical and quantum physics, as well as their mathematical foundations. They also reinforce their knowledge of analysis and computer science.

In the third year, students consolidate their understanding of quantum physics and are introduced to modern physics, with topics such as nuclear and subnuclear physics and the structure of matter. They also acquire basic knowledge of chemistry.

**Expected learning outcomes**

Expected Learning Outcomes

Referring to the qualifying educational objectives of the degree class and the specific training goals, the graduate in Physics develops a range of skills as defined by the expected learning outcomes. The main competencies acquired by graduates, based on the Dublin Descriptors framework, are as follows:

Knowledge and Understanding

Through foundational education in physics and other disciplines covered by the degree program, graduates will acquire:

- Understanding of the scientific method.
- Knowledge and comprehension of classical physics: mechanics, thermodynamics, electromagnetism, optics, wave

propagation, fluid dynamics, and analytical mechanics.
- Knowledge and comprehension of modern physics: quantum mechanics, quantum theory of matter, nuclear and subnuclear physics, and special relativity.
- Basic understanding of chemistry.
- Interdisciplinary perspective in studying physical phenomena and the ability to contextualize problems within a broad and historical-scientific framework.
- Mathematical knowledge: mathematical analysis, linear algebra, geometry, complex analysis, and elements of functional analysis.
- Computational knowledge: procedural and object-oriented programming, numerical problem-solving techniques, and computer networks.
- Basic knowledge of electronics and electronic instrumentation: analog and digital electronics (basic concepts), use of instrumentation, and simple data acquisition systems.
- Intermediate knowledge in a specialized area of physics, such as astrophysics, environmental physics, medical physics, statistical physics, geophysics, or general relativity.
These skills are developed through lectures, exercises, laboratories, and independent study, as outlined in the individual study plans. Guided elective courses, free-choice educational activities, and the final thesis provide opportunities for further specialization. Knowledge and comprehension are assessed through written and/or oral exams, including mid-term evaluations. Laboratory courses involve oral or practical assessments and written reports, sometimes in English, to verify critical thinking, experimental techniques, and data analysis skills.

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Applying Knowledge and Understanding
Thanks to their methodological, technological, and instrumental competencies, even in multidisciplinary and applied contexts, graduates will be able to:
- Apply the scientific method to study physical phenomena and analyze experimental data.
- Build and develop simple mathematical models of reality.
- Perform basic laboratory measurements using modern instruments and process the data with statistical methods and computational tools.
- Utilize sensors and detectors for physical signals and measurement instruments, including computer-controlled devices.
- Operate specific instrumentation in fields such as astrophysics, nuclear physics, materials physics, electronics, optics, environmental physics, or cultural heritage physics.
- Work effectively in teams, as practiced in experimental and computational physics laboratories, and during the preparation of the final thesis.
These skills are acquired through curriculum courses and are particularly honed during laboratory-based courses and thesis preparation. Assessment includes oral and/or written exams, requiring students to demonstrate mastery of tools, methodologies, and applications. Comprehensive evaluation occurs during thesis development and presentation.

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Making Judgements
Graduates will develop:
- The ability to evaluate and interpret experimental data obtained in the laboratory.
- The capacity to assess critical applications (e.g., biomedical imaging, dosimetry, avionics, automotive) based on experimental data from laboratories or research agencies.
- Awareness of social and ethical responsibilities related to applying their knowledge.
- Independent evaluation skills for educational methods.
- Self-assessment skills in scientific contexts or regarding workforce integration.
Judgment skills are fostered through group work in laboratories, report writing, collaborative study, participation in scientific seminars (including CV writing workshops), critical discussions with professors, and thesis preparation. Evaluation is carried out by assessing independently written laboratory reports and specific exam components, including the final thesis.

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Communication Skills
Throughout their studies, graduates will develop the ability to communicate information, ideas, problems, and solutions to both specialists and non-specialists. Specifically, they will gain:
- Proficiency in oral and written communication, using precise language and scientific rigor, while adapting the focus and detail of the message.
- The ability to present experimental and theoretical results effectively using modern multimedia tools.
- Proficiency in English (B1 level), with a focus on scientific vocabulary and technical terminology in physics.
These communication skills are developed through exams, laboratory reports, seminars, active participation in classes, and the preparation and presentation of thesis results. Assessment occurs during exams and the final thesis defense.

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Learning Skills
Through their academic journey, graduates will cultivate an aptitude for deepening and expanding their knowledge. They will acquire:
- The ability to effectively utilize textbooks and scientific publications in English.
- Skills in bibliographic research.
- Competence in consulting databases and electronic journals.
- Proficiency in reading textbooks and specialized journals within a specific physics research field.

Learning skills are developed throughout the program, especially during thesis preparation, and are evaluated through activities requiring independently prepared reports and the final thesis.

**Professional profile and employment opportunities**

Professional Profile and Career Opportunities

The degree program prepares students for the profession of physicist.

Roles in the Workplace

The functions that graduates may perform in professional contexts include, but are not limited to:

- Scientific analysis and framing of measurable phenomena of interest.
- Design and development of simple prototypes.
- Efficient use and development of measurement instrumentation.
- Measurement of natural phenomena (e.g., radioactivity, electromagnetic fields).
- Data analysis, including statistical analysis (data scientist).
- Development of mathematical-statistical models across a broad spectrum of contexts (e.g., mechanics, finance, medicine).
- Organization and coordination of workgroups.
- Industrial process and quality control.
- Dissemination and promotion of scientific culture.
- Technical-scientific training for staff and/or external users.
- Design of innovative educational proposals.
- Preparation of scientific reports, books, essays, etc.

To achieve higher levels of responsibility in these functions, graduates may need to acquire additional skills by pursuing a master's degree, a first-level internship, or specific professional training.

Skills Associated with These Roles

During the degree program, physicists acquire competencies enabling them to either continue with advanced education or perform the professional functions listed above. These competencies are grounded in a robust scientific foundation and an open-minded approach, and include:

- Expertise in all aspects of classical and modern physics.
- Mathematical, statistical, and computational skills.
- Ability to stay updated, learn, and explore with an open mind.
- Proficiency in applying the scientific method.
- Leadership and the ability to coordinate, harmonize, and motivate team efforts.
- Skills in processing and interpreting statistical data based on physical theories or models.
- Competence in using and interfacing instrumentation with computers for optimized measurements.
- Effective communication on scientific topics, including proficiency in English.

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Career Opportunities

While graduates typically continue their education in advanced studies, they may also pursue careers in industry, public institutions, or private organizations, working in structures such as:

- Research centers and laboratories.
- Hospitals and healthcare facilities using diagnostic, therapeutic, and radioprotection techniques.
- Astronomical observatories.
- Museums and other centers for scientific dissemination.
- Banks and insurance companies.
- Organizations focused on developing mathematical-statistical models of phenomena.
- Facilities for using and developing complex systems and instrumentation.
- Centers dedicated to the restoration of artistic heritage and environmental protection.
- Energy production plants (including nuclear power plants).
- International centers monitoring nuclear energy and enforcing nuclear weapons prohibitions.
- Facilities for data acquisition and processing.

Graduates interested in roles requiring additional training will pursue master's degrees, first-level professional master's programs, advanced work-training courses, or internships to acquire qualifications such as radiation protection expert.

**Initial knowledge required**

Admission requirements

Qualifications and knowledge required for admission

Applicants to the Bachelor's degree programme in Physics must hold an upper secondary-school diploma or an equivalent qualification obtained abroad.

Admission to the programme is open, subject to a mandatory, non-selective assessment test before enrolment. The test is aimed at ascertaining the candidate's educational background, in terms of knowledge and understanding of the basic scientific disciplines, especially mathematics and elementary logic. The test syllabus is available at:
https://www.cisiaonline.it/en/area-tematica-tolc-scienze/struttura-della-prova-e-syllabus/

Admission assessment

Candidates are usually assessed through the TOLC CISIA Online Test, to be taken at the University of Milan or any other universities belonging to the Consortium of Inter-University Integrated Access Systems (CISIA). Students have to register for the TOLC test on the CISIA website (www.cisiaonline.it).

Admission of transfer or graduate students
Transfer students from a degree programme of the University of Milan, or another university, and graduate students will be waived from the test requirement only if they are admitted to years subsequent to the first.
For further details, please see the call for applications

Admission Test (TOLC) Requirements
To enroll in the Bachelor's Degree Program in Physics, students must take one of the following TOLC tests: TOLC-S or TOLC-I.
Students may enroll regardless of their test results.

• TOLC-S: Details about the test structure, topics covered, and other useful information are available at the following link: https://www.cisiaonline.it/area-tematica-tolc-scienze/struttura-della-prova-e-sillabo/

• TOLC-I: Details about the test structure, topics covered, and other useful information are available at the following link: https://www.cisiaonline.it/area-tematica-tolc-ingegneria/struttura-della-prova-e-sillabo/.

Each TOLC test includes an additional English section, consisting of 30 questions to be answered in 15 minutes. This section does not replace the for-credit English proficiency assessment required by the degree programme, but serves as a self-assessment tool for the student.

Other equivalent tests may be accepted on a case-by-case basis, with the prior approval of the Academic Board.

Additional learning requirements (OFA) and remedial activities
First-year students who have not achieved at least 10 points in the Mathematics module will have to fulfil additional learning requirements (OFA) for this subject within the first year of the programme.
Remedial activities and tests: students with additional learning requirements will have to carry out remedial activities in the period October-December, and then pass a test to prove they have filled their gaps. Otherwise, they will not be allowed to take any second-year exams before passing the Mechanics exam (https://fisica.cdl.unimi.it/it/studiare/le-matricole).

Test topics, registration procedures, dates, deadlines and other information are specified in the call for applications: https://fisica.cdl.unimi.it/it/iscriversi

**Degree programme final exams**
Characteristics of the Final Exam
Once the required educational credits have been earned, in compliance with these regulatory provisions, the student is admitted to take the final exam, which allows them to obtain the remaining credits (CFUs) necessary for the degree.
The final exam includes the preparation of a report, not necessarily original, related to a theoretical or experimental research activity aimed at solving a physical or technological problem.
The report is developed under the guidance of one or more professors and subsequently discussed before a degree committee.

Before starting the activity for the report, the student must submit an application indicating a title, even a provisional one, to the Thesis Committee, which will review and approve it if it is consistent with the student's academic path. At this stage, the committee will assign one or more supervisors and co-supervisors.
The assignment of the report is subject to the successful completion of the Electromagnetism exam.

The official assignment of the paper is a MANDATORY step that must precede any preparatory work on it. This process entails taking responsibility on the part of the supervisors and co-supervisors and verifying all formal aspects, including for insurance purposes. The students must submit the application for the report's assignment electronically by visiting the page: https://registrazione.fisica.unimi.it/richiesta-tesi/login.

To be eligible to take the final exam, the student must have earned 173 CFUs. Additionally, there must be a match between the completed exams and the most recently approved study plan.
With the discussion of the report, the student's academic journey concludes, enabling the graduate to enter the workforce or enroll in a master's degree program.

**Notes**
Tutoring
The Bachelor's Degree Program organizes tutoring services for certain courses to assist students during the lecture periods.
The professors responsible for the relevant courses will provide students with detailed information and communicate the tutoring schedules.

For-credit assessment B1

In order to obtain their degree, students must be proficient in English at a B1 level under the Common European Framework of Reference for Languages (CEFR). This proficiency level may be certified as follows:

- By submitting a language certificate attesting B1 or higher level in English and issued no more than three years before the date of submission. You will find the list of language certificates recognized by the University at: https://www.unimi.it/en/node/39322). The certificate must be uploaded during the enrolment procedure, or subsequently to the portal http://studente.unimi.it/uploadCertificazioniLingue;
- By taking a placement test offered by the University Language Centre (SLAM) between October and December of the first year. Students who fail the test will be required to take a SLAM course.

The placement test is mandatory for all those who do not hold a valid certificate attesting to B1 or higher level.

Those who have not taken the placement test by the end of December or fail the end-of-course exam six times must obtain the necessary certification privately before graduating.

## *EXPERIENCE OF STUDY ABROAD AS PART OF THE TRAINING PROGRAM*

The University of Milan supports international mobility by providing its students with the opportunity to spend study and internship periods abroad. It is a unique chance to enrich your educational path in a new exciting environment.

The agreements entered into by the University with over 300 universities from the 27 EU member countries under the European Erasmus+ programme allow regularly enrolled students to carry out part of their studies at one of the partner universities or to undertake internships at companies, training and research centres and other organisations.

Similar international mobility opportunities are provided outside Europe, through agreements with a number of prestigious institutions.

The University of Milan is a member of the 4EU+ European University Alliance that brings together eight public multidisciplinary universities: University of Milan, Charles University of Prague, Heidelberg University, Paris-Panthéon-Assas University, Sorbonne University of Paris, University of Copenhagen, University of Geneva, and University of Warsaw. The 4EU+ Alliance offers integrated educational pathways and programmes to promote the international mobility of students (physical, blended and virtual).

**Study and internships abroad**

What the Degree Program Offers

Third-year students may occasionally have the opportunity to conduct their thesis work abroad at prestigious research institutions, such as the CERN in Geneva or the GSI in Darmstadt, or at renowned foreign universities.

These opportunities are made possible within the framework of international collaborations associated with the research activities of the faculty.

Additionally, students may undertake internships as part of these international collaborations.

**How to participate in Erasmus mobility programs**

How to participate in Erasmus+ mobility programmes

The students of the University of Milan can participate in mobility programmes, through a public selection procedure.

Ad hoc commissions will evaluate:

- Academic career
- the candidate's proposed study programme abroad
- his/her foreign language proficiency
- the reasons behind his/her application

Call for applications and informative meetings

The public selection for Erasmus+ mobility for study generally begins around February each year with the publication of a call for applications specifying destinations and requirements. Regarding the Erasmus+ Mobility for Traineeship, the University of Milan usually publishes two calls a year enabling students to choose a destination defined by an inter-institutional agreement or to find a traineeship position on their own.

The University organises informative meetings to illustrate mobility opportunities and rules for participation.

Erasmus+ scholarship

The European Union grants the winners of the Erasmus+ programme selection a scholarship to contribute to their mobility costs, which may be supplemented by the University funding for disadvantaged students.

Language courses

Students who pass the selections for mobility programmes can benefit from intensive foreign language courses offered each year by the University Language Centre (SLAM).

https://www.unimi.it/en/node/8/

Learn more at https://www.unimi.it/en/node/274/

For assistance, please contact:
International Mobility Office
Via Santa Sofia 9 (second floor)
Tel. 02 503 13501-12589-13495-13502
Contacts: InformaStudenti;
Student Desk booking through InformaStudenti

## *1st COURSE YEAR Core/compulsory courses/activities common*

| Learning activity | Ects | Sector |
|---|---|---|
| COMPUTER SCIENCE | 6 | INF/01 |
| English assessment B1 (3 ECTS) | 3 | ND |
| GEOMETRY 1 | 7 | MAT/03 |
| MATHEMATICAL ANALYSIS 1 | 8 | MAT/05 |
| MATHEMATICAL ANALYSIS 2 | 8 | MAT/05 |
| MECHANICS | 8 | FIS/01 |
| PHYSICS LABORATORY WITH INTRODUCTION TO STATISTICS | 10 | FIS/01 |
| WAVES AND OSCILLATIONS | 7 | FIS/01 |
| Total compulsory credits | 57 | |

## *2nd COURSE YEAR (available as of academic year 2026/27) Core/compulsory courses/activities common*

| Learning activity | Ects | Sector |
|---|---|---|
| CLASSICAL MECHANICS | 7 | MAT/07 |
| ELECTROMAGNETISM | 15 | (5) FIS/07, (10) FIS/01 |
| ELECTRONIC INSTRUMENTATION LABORATORY | 6 | FIS/01 |
| EXPERIMENTAL DATA PROCESSING LABORATORY | 6 | FIS/01 |
| LABORATORY OF OPTICS AND MODERN PHYSICS | 6 | FIS/01 |
| MATHEMATICAL ANALYSIS 3 | 6 | MAT/05 |
| MATHEMATICAL METHODS IN PHYSICS | 7 | FIS/02 |
| QUANTUM PHISYCS 1<br>*The exam for this course will be taken in the third year, upon completion of the Quantum Physics module (Module 2), and will result in the verbalization of a single 15 CFU Quantum Physics exam* | 7 | FIS/02 |
| THERMODYNAMICS | 6 | (3) FIS/07, (3) FIS/01 |
| Total compulsory credits | 66 | |

## *3rd COURSE YEAR (available as of academic year 2027/28) Core/compulsory courses/activities common*

| Learning activity | Ects | Sector |
|---|---|---|
| CHEMISTRY 1 | 6 | CHIM/03 |
| INTRODUCTION TO NUCLEAR AND PARTICLE PHYSICS | 9 | FIS/04 |
| QUANTUM PHISYCS 2 | 8 | FIS/02 |
| STRUCTURE OF MATTER 1 | 9 | FIS/03 |
| Total compulsory credits | 32 | |

## *Further elective courses*

**One course chosen from among**

| | | |
|---|---|---|
| ASTRONOMY LAB | 6 | (3) FIS/05, (3) FIS/01 |
| COMPUTATIONAL PHYSICS LABORATORY | 6 | (3) FIS/07, (3) FIS/02 |
| CONDENSED MATTER PHYSICS LABORATORY | 6 | (3) FIS/03, (3) FIS/01 |
| EARTH PHYSICS LABORATORY | 6 | (2) FIS/07, (2) FIS/06, (2) FIS/01 |
| ELECTRONICS 1 | 6 | (3) ING-INF/01, (3) FIS/01 |
| ELECTRONICS LABORATORY | 6 | (3) ING-INF/01, (3) FIS/01 |
| GAMMA SPECTROSCOPY LABORATORY | 6 | (3) FIS/04, (3) FIS/01 |
| INTRODUCTION TO ASTROPHYSICS | 6 | FIS/05 |
| INTRODUCTION TO GENERAL RELATIVITY | 6 | FIS/02 |
| INTRODUCTION TO GEOPHYSICS | 6 | (2) GEO/10, (2) GEO/12, (2) GEO/11 |
| INTRODUCTION TO HEALTH AND MEDICAL PHYSICS | 6 | FIS/07 |
| INTRODUCTION TO QUANTUM SCIENCE AND TECHNOLOGY | 6 | FIS/03 |
| INTRODUCTION TO STATISTICAL PHYSICS | 6 | (3) FIS/03, (3) FIS/02 |
| NUCLEAR PHYSICS LABORATORY | 6 | (3) FIS/04, (3) FIS/01 |
| NUMERICAL SIMULATION LABORATORY | 6 | (3) FIS/03, (3) FIS/02 |
| OPTICS LABORATORY | 6 | (3) FIS/03, (3) FIS/01 |
| PHYSICS LABORATORY FOR THE ENVIRONMENT AND CULTURAL HERITAGE | 6 | FIS/07 |

**It is recommended to choose a Laboratory course from the ones mentioned above.**
**The student must also acquire 12 CFU by freely choosing from all the courses offered by the University, provided that they**

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| **are culturally consistent with their educational path and do not overlap in content with the already used fundamental and optional courses in the study plan. This choice also includes all the courses listed in the above table of Elective Activities.** |
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| ***End of course requirements*** | | | |
|---|---|---|---|
| FINAL EXAM | | 7 | NA |
| | Total compulsory credits | 7 | |

## *COURSE PROGRESSION REQUIREMENTS*

***The course contains the following obligatory or advised prerequisites***

| Learning activity | Prescribed foundation courses | O/S |
|---|---|---|
| MATHEMATICAL ANALYSIS 3 | MATHEMATICAL ANALYSIS 2 | Core/compulsory |
| | MATHEMATICAL ANALYSIS 1 | Core/compulsory |
| MATHEMATICAL ANALYSIS 2 | MATHEMATICAL ANALYSIS 1 | Core/compulsory |
| THERMODYNAMICS | MECHANICS | Core/compulsory |
| ELECTROMAGNETISM | MECHANICS | Core/compulsory |